

International Symposium on Nuclear Fuel Cycle

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Venue: Tokyo, Japan

September 4, 2005

*These minutes were created based on recorded simultaneous translation of the symposium.

(MC)

Its five minutes before opening time please be seated at this time.

Several announcements that would like to make before opening the symposium.

This will be an open symposium. So, photographs and video may be reported in the media. There is simultaneous interpretation; channel one is for Japanese and channel 2 is for English.

Please turn off the power to the interpreting receivers and return them at the exit when you leave. Please make sure you do not take them home with you. Also we have inserted a questionnaire in the program so we ask that you fill it out before the end of the symposium.

Also, please read the backside of the program which outlines additional requests and housekeeping notes so please read them while we wait for the opening of the symposium. Thank you.

(MC)

Ladies and gentlemen thank you for waiting.

We would like to start the international symposium on nuclear fuel cycle.

First I would like to ask the organizer, Mr. Sato the governor of Fukushima prefecture, to give us some opening remarks.

(Governor Sato)

I am, Sato, the governor of Fukushima prefecture at the opening of the international symposium on nuclear fuel cycle I would like to say a few words. I would like to thank Mr. Kato, the representative of Japan Initiative, who is going to serve as a coordinator for the symposium and also all the panel members who have come to join this symposium from both outside and inside of Japan out of your busy schedule. And I would also like to thank all the audience to take part in this symposium even on Sunday. Fukushima prefecture, since the Meiji Era, has been the largest supplier of electricity to the Tokyo metropolitan area using hydro fuel-cell and nuclear and geothermal energy. We are supplying a quarter of the demand in the Tokyo metropolitan area and we have right now ten nuclear reactors, so it is a great challenge for the prefectural politics to keep safety and a relief of the people. Our prefecture has accepted the energy policy as national policy and has been cooperating with it. But the prefectures where the nuclear facilities and energy facilities are located could be affected by the trend of energy policy in terms of safety, community promotion and even our existence. So, in May 2001 we have established an energy policy study group within the prefectural government and discuss the energy policy as a whole from the perspective of electricity supplying prefecture. In September 2002, we have put together an interim report on the policy decision making process, energy policy and nuclear power generation positioning. And as for nuclear fuel cycle since this is a very grave issue that could affect the people's everyday lives in terms of safety and the economy, we have been suggesting to the national government to take every possible opportunity that they should encourage public debate before they make a final decision. And the government has started the chokei (Long-Term program for Research, Development and Utilization of Nuclear Energy) planning council to discuss multiple scenarios including direct disposal but, unfortunately in less than four months time they have concluded that the reprocessing option will be continued. So, we hope that the people who are the experts in this field would explain what the points of disagreements among the experts in easy-to-understand manner and I hope that this symposium will be a lively and easy to follow discussion. Thank you.

(MC)

At this time I like to introduce the coordinator and panel members today. As for the detailed profile I would like you to refer to the backside of handouts. From the left side on the stage, Professor Takeo Kikkawa from the Institute of Social Science of Tokyo University, next we have Mr. Mycle Schneider, international consultant on energy and nuclear policy, professor Youji Uchiyama, from the Graduate School of Systems and Information Energy from the University of Tsukuba, and Mr. Tetsunari Iida, the director of the Institute for Sustainable Energy and Professor Frank N. von Hippel, Public and International Affairs at Princeton University, and Mr. Tomio Kawata, executive director of Japan Nuclear Cycle Development Institute and Mr. Hideki Kato, the coordinator, and Professor Hitoshi Yoshioka, graduate school of Kyushu University, and Professor Hajimu Yamana, Research Reactor Institute of Kyoto University, and from Germany, the Institute of Applied Ecology, Mr. Christian Küppers. Mr. Yo Fujimura, faculty of science from Kyoto University and Graduate School of Science. Now I would like to hand the microphone to Mr. Kato, the coordinator for today.

(Mr. Kato)

I am Kato from the Japan Institute. It is going to be a long day today, but we would like to discuss the nuclear fuel cycle. That is the theme for today's discussion and we have invited many experts to discuss this issue. Earlier Governor Sato from Fukushima prefecture talked about this, but as he said, since the Meiji Era from the perspective of the generating power, Fukushima prefecture has been involved in this area and people in Tokyo are the users of the electricity and Fukushima prefecture is the producer of the electricity and their positions may be different. Obviously there are advantages and disadvantages for each perspective position. Having the nuclear power stations and being involved and understanding the nuclear fuel cycle, Fukushima prefecture and as an organizer has hosted this type of discussion which is quite beneficial for all of us. For those of you who are gathered here as an audience probably you have a high level of knowledge in this area. However, probably I am the only one who is a layman in this field here today and when the government makes decisions what we can see is something that is evident or apparent from outside. We have invited three experts from outside of Japan as well so we would like to clearly define what the discussion points are and I hope that this discussion will be further thought for all of you. And, if there is a further discussion triggered by this symposium that would be beneficial. The general elections will be held in a few days

but it is never too late to have such discussions and there will be specific presentations and discussions from experts but today's theme, the nuclear fuel cycle, is about how to process and dispose of nuclear fuel the safety and technology and security assurance and international nuclear proliferation, those are some of the vantage points that we will apply to this discussion. And, how we should evaluate those before the government makes decisions. In other words the information disclosure about the decision-making process of the government and how the government has explained to the general public, those are some of the points that we need to discuss. We would like to have discussion and hear from both those who are pro-policy and anti-policy, pro-nuclear-reprocessing and anti-nuclear-reprocessing. There would be three different sessions, the first will be about safety and environmental compatibility, session two will deal with energy security and nuclear nonproliferation and session three is about economic considerations. But, there are other issues such as technology and the accountability on the part of the government when they decide policies. So, those will all probably be discussed throughout the three sessions. I would like to ask the official from the Fukushima prefectural government to explain about the Interim Report put together by the government.

(Policy Administrator Goto)

Thank you. I am Goto from Fukushima Prefecture. We have distributed to you a document entitled the Interim Report on Nuclear Fuel Cycle. I apologize that the document number is not shown, it is a stapled document. It is the Interim Report on the nuclear fuel cycle, which is part of the packaged document. At the planning council this was decided in December of last year and this is what we are evaluating in today's panels. I would like to introduce to you the contents of the Interim Report. It's entitled Interim Report on nuclear fuel cycle in Japanese. In the process of deliberations concerning how to proceed with nuclear fuel cycle policy four basic scenarios were set up. Scenario one is that spent fuel will be stored for an appropriate amount of time and later will be reprocessed. Scenario two, reprocessing will be conducted but the amount surpasses the capacity of reprocessing will be disposed directly. Scenario three is direct disposal. Scenario four is for the time being spent fuel will be stored and later it will be chosen whether to do reprocessing or direct disposal. I am sure that most of you here know that concerning processing, it's reprocessing or direct disposal, there is a big debate going on. Reprocessing is that you do chemical treatment of spent fuel. So, from the spent fuel you are trying to take plutonium and uranium to try to reuse such substances. In contrast to that, direct

disposal is when you think that there are a lot of safety concerns if you try to chemically treat the spent fuel so you should directly dispose of that spent fuel. So, that is the thinking of direct disposal. I would like to explain the four scenarios. They decided to look at this from 10 viewpoints. Safety assurance, energy security, and onwards, 10 viewpoints. A comprehensive review was supposedly done. Moving on to page two, evaluation of the basic scenarios. So, the four scenarios we evaluated. Parenthesis one. Evaluation required from the viewpoint of the precondition. And, in terms of safety assurance it's possible to secure the necessary standard of safety for all the scenarios. There was a indication made with scenario one and two that there will be a large amount of release of radioactive material however, it satisfies other safety standards of public exposure and it's markedly lower than the natural radiation so there is no significant difference between scenarios. Next, in terms of technical viability, for reprocessing we already have institutions and implementing entity and expanding technical sending vitrified waste. In contrast to that, for direct disposal we do not have the accumulation of technical knowledge enough to judge the appropriateness of direct disposal in the domestic environment. On page three, the next evaluation for the comparison of various policies and their significance. Scenario one (reprocessing) is inferior in terms of economics, but it is superior in terms of energy security you save uranium resources by 10 to 20 percent and in terms of environmental compatibility 1000 years later, the potential hazard of the vitrified waste is 1/8, the volume of the high-level waste is 30 to 40 percent and the area of the disposal site is one half to two thirds. So, reprocessing is more compatible with the material circulation society. And, if you also include the cost associated with policy change, there is a possibility that it would not be inferior in economics as well. Now scenario three(direct disposal) is superior in terms of economics but you are putting plutonium under the ground without putting it under human control so it is inferior to scenario one(reprocessing) in terms of energy security and environmental compatibility. Page four, in terms of nuclear nonproliferation, scenario one(reprocessing) you have technical measures and faithfully implement international commitments. Scenario three(direct disposal) after the disposal for a few hundred or tens of thousands of years you need to establish monitoring and physical protection methods that are internationally agreeable and effective and efficient and that needs to be implemented. So in that sense no significant differences in scenarios in terms of proliferation. Next, various limiting factors, scenario three(direct disposal) requires depositing, it will be difficult to find the final disposal site for spent fuel including plutonium which would be more difficult than finding a site for vitrified waste. Also, the siting of interim storage facilities will stall

as well as the shipping out of spent fuel from nuclear power plants and power plants will have to be stopped. Fourth, from the viewpoint of maintaining choice, scenario one(reprocessing), we will be able to maintain the technical innovation, infrastructure and international understanding of Japan's approach to reprocessing so it will be able to deal with uncertainties in the future. So, next page, the basic thinking for the future is shown and at the bottom of parentheses one, the basic policy should be to effectively utilize the plutonium and uranium recovered from reprocessed spent fuel, the reasons are as follows. Compared with direct disposal if you do not consider the cost of policy change under the current uranium prices and the technical knowledge, it's inferior in economics but superior in terms of energy security and environmental compatibility and the ability to deal with future uncertainties. Also, the government and private companies have been accumulating the social assets to realize nuclear fuel cycle and that should be maintained. And on the next page, if we were to change policy to direct disposal as was mentioned earlier the nuclear power plants are expected to stop one after another and it would be difficult to site interim storage facilities and final disposal sites. The basic policy for the time being, within the capacity of reprocessing that will be made available reprocessing will be done and the surplus should be stored in the interim storage, and in terms of what to do with that temporarily stored spent fuel a study will begin from about 2010. Page eight, plu-thermal and the location of interim storage must be pursued and we need stable and smooth operation of the Rokkasho plant and the government and the parent companies should conduct necessary research and development to prepare for future uncertainties. Now, page 13 and onwards, we have a draft outline of the fundamental nuclear policy, and that is all for myself.

(Mr. Kato)

Mr. Goto, direct disposal and storing for the moment, what you mean by those two terms?

(Policy Administrator Goto)

Before disposal, you have to keep spent fuel for a while, this is called interim storage.

(Mr. Kato)

Where do you put it?

(Policy Administrator Goto)

There is a lot of debate about this. In our country we do not have any official interim storage sites yet. They are stored in at site or at the Rokkasho reprocessing plant storage site.

(Mr. Kato)

Is that underground in our country?

(Policy Administrator Goto)

We don't have it yet in our country. In terms of interim storage, in Europe or in Germany, there is already a site. In Japan, Mutsu city and TEPCO is asking for permission to build an interim site at Aomori prefecture, the go sign has not been given yet.

(Mr. Kato)

If I may summarize this very roughly, to do reprocessing you need a huge factory plant and if that plant does the reprocessing, the disposal of that facility itself is going to be a major task several decades later. If you do direct disposal, you would bury it in the ground so you need someplace where you can do that and that will be an issue. So, scenario four, do not make a decision now, let us wait until things become clear. But, then there is the issue of where to store the material until that time. So, location, whether to accept or not, technology, cost, these are the factors involved I guess. And, in the Interim Report it is saying that all these issues have been resolved, but people opposed to that saying that discussion is still insufficient so we need more discussion. Is that a correct general understanding?

(Policy Administrator Goto)

Yes.

(Mr. Kato)

Well then concerning this Interim Report from a critical perspective there is this ICRC (International Critical Review Committee) initiative.

Mr. Yoshioka and Mr. Iida have established international evaluation panel and the main members of this panel are the three experts from overseas today. Mr. Iida, could you please just briefly explain the ICRC panel?

(Mr. Iida)

I am Iida from ISEP and I would like to explain about the background and purpose of ICRC and the more detailed contents will be more explained by Mr. Yoshioka, the panel chairman. Please take a look at page two. Why we are trying to reevaluate the Interim Report, this is the critical of the developments in this field for the chokei(Long-Term program for Research, Development and Utilization of Nuclear Energy) revision and chokei(Long-Term program for Research, Development and Utilization of Nuclear Energy) policy planning committee was established last year but in the electricity business sub-department of METI the systematic framework was established. Once that the systematic framework was established by the METI the responsibility was left to the Japanese Atomic Energy Commission whether to promote the nuclear fuel cycle or not. The Interim Report was put together on November 12 last year concluding that nuclear reprocessing. And, Rokkasho is mentioned here but this is a private business so the policy planning commission was not the place for a final decision but actually upon this Interim Report, the uranium test at Rokkasho reprocessing plant was started in December of last year. And reprocessing cumulative fund act was enacted this year. So, the outline of the nuclear policy and revision of the chokei(Long-Term program for Research, Development and Utilization of Nuclear Energy) is now about to be put together. The nuclear reprocessing and Rokkasho nuclear plant opening are all kind of loosely integrated but the Interim Report will be the central core of the whole development so we decided to further develop this and if we decide to withdrawal from the nuclear reprocessing, if the Rokkasho reprocessing plant active test is not started yet then it will be still economic to withdraw. That is why we have taken this timing. Yesterday we had a meeting from the perspective of civil science and Mr. Küppers made the presentation and in the academic field peer review is being conducted. Dr. Einstein's paper, which was published after Dr. Einstein became quite well-known, was refused of for publication by the peer review. And, policy making also needs this peer review and this has to be evaluated by an independent party. That was Mr. Küppers point yesterday. But, actually the Japanese national government has put together this Interim Report and is trying to compile the outline of nuclear policy almost unilaterally. So, before we let them do so we would like to get an independent review on this panel. And, Professor Yoshioka has been a member of this policy planning commission and on November 12 at the time of the Interim Report disclosure Professor Yoshioka pointed out the necessity for international review. And, for us the Takagi Fund for Citizen Science, as for nuclear fuel cycle policy, we have been discussing the necessity for the review

from citizens of science perspective and the peer review for public policies should be conducted. And, that is how we established the ICRC. And the members are listed on the screen. Our members are mostly anti-nuclear-reprocessing and we have the US, UK, Germany, and France represented as members and also the researchers from both outside and inside of Japan have a certain recognition in their field of expertise as members. Professor Yoshioka, please explain the discussion of the panel.

(Mr. Yoshioka)

This is Yoshioka speaking. I would like to explain about the report of the ICRC.

This report is currently being compiled, within 10 days it is expected to be completed and made available for distribution. What is being distributed today is a draft of the overview including the summary of the reviews by four overseas experts. And, this should be fixed in several days.

Next slide. Mr. Iida already explained. If you publish academic papers or design new facilities, we should have people review that, people understand that and review that. But in terms of public policy, it's difficult to find people who can evaluate that. Most of the documents are in Japanese so it was rather difficult effort to have international review of the policy. I told the AEC (Atomic Energy Commission) to do the international review but they would not. So, were still funding from the Takagi Fund and the review was done by an NGO initiative. So there was a lot of effort that went into this. And a lot of difficulties had to be dealt with in materializing this.

This is a list of the panel members. Not everyone are those who want to nuclear phase out, and there are some people who are not necessarily anti-nuclear but we wanted a wide range of views so this is the makeup of the panel.

This is the issue concerning logic. I believe that this way of making decisions is irrational. In the Interim Report they settled four so called basic scenarios and compared scenarios with the assumption that each of the business cases were to be implemented completely successfully. But, in reality we are at a time when the Rokkasho plant is about to be operated and the bill for the reserve fund is being deliberated. We need to discuss the policy options for these specific issues. I have been making that point ever since the early stage of deliberations, but we were given these four pointless basic scenarios and 10 review items which does not make much sense. And, I said that this would not stand a legitimate review. But, that has been a history of this.

In terms of methodology, I just said that it's fine that you do a comprehensive evaluation of multiple choices of policy, but in the Interim Report the choice of policy

was not evaluated so this is meaningless as a basis for choosing policy. That is the first point.

And in terms of backend work, various developments are now taking form but in the Interim Report the assumption was that these kinds of operations will be started from Greenfield and the assumption was that it would all be operated completely successfully. And, some adjustments were made but, in terms of methodology, that has not been done on a rational basis.

Now in terms of methodology of a comprehensive policy evaluation, I do not think that meaningful demonstration was conducted so I give a score of zero to the output of the Interim Report, but putting that aside, let us look at each individual item. We felt that we needed to review discussion of the Interim Report on each individual item. There were 10 items, and the important ones are five items. For them, I would like to see whether the conclusion of the Interim Report is appropriate.

Concerning the nuclear non-proliferation, they say that it is appropriate safeguards and physical protection that there is no significant difference, but from our viewpoint, it is impossible to have appropriate physical protection and safeguards. So you cannot just say if we have appropriate physical protection and safeguards, so in that sense this does not really stand.

In terms of safety, if the reprocessing has done properly, there will be no accidents, and relatively the amount of radiation is larger but it does not reach the safety standards, so there is no significant difference. That is what they say but, historically we've seen that safety is not assured and that is why we are raising the issue. So you do not have any grounds for putting the assumption that if things are done appropriately. Actually, we have seen actually cases of waste fluids being accumulated, so you cannot say if it's operated appropriately.

Third point, energy security, if we do reprocessing, some useful fuel materials can be removed, and you will save 10 percent if you use plutonium and 20 percent if you also use uranium, but 10 to 20 percent difference is not a significant amount. That is our consensus. Even if that was significant, there should be other choices for saving 10 percent, and debate should be conducted about what is the most cost-effective method. I think this viewpoint itself is not too relevant. That is the conclusion of our discussion.

Next page. In terms of economics of disposal, reprocessing is much more expensive. That has been the global consensus, and the Interim Report, concerning the evaluation for economics, showed the same kind of result. We appreciate their honesty and we appreciate that we are finally able to have some common grounds on this, but then they

add the policy change costs and say that if we stop or freeze the Rokkasho plant, by 2015 all the spent fuel will have nowhere to go by 2015 and, in the worst case, until 2020 there will be no place to put the spent fuel, and majority of the power plants will have to stop. Now, I can understand if there is a slight possibility, but they make this groundless assertion that there is a high possibility that this will happen, and that is why this economics evaluation is also flawed.

In terms of environmental compatibility, plutonium, which is to be wasted under the direct disposal line, will be reutilized. But the effect of this is problematic the problem. Is that really going to lead to a lower environmental burden? In any case, you will be burying horrible waste under ground, and the hazard is not going to be that much different even if you remove the plutonium. That is one point made. And, in the course of reprocessing, and in various related processes, there will be other burdens on the environment so as a total environmental burden will not lessen. And, in terms of processing, the spent MOX fuel most likely will not be reprocessed. And, so we cannot accept that reprocessing is more environmentally compatible.

The other issues I will skip because they are less important. But for these five issues, in each case we have come to the conclusion that the interim report does not stand as an objective evaluation. We concluded that the policy recommendation of the interim report have to be abandoned, because they are poorly made both in terms of the overall logic and also in terms of the individual topics.

I will take only three or four more minutes. From each of the overseas panelists we received reviews in each of the areas of strengths, and within 10 days I promise you that we will provide to you their reports with the Japanese translation. Basically their responses are similar to what I have just said. They stressed that there was the lack of any clear weighing system for the ten issues evaluated. Also, the selection of criteria in each issue is very arbitrary. They stressed that the methodology is unreliable and so the result is also unreliable. That was pointed out by all of the reviewers.

Next page. Page 11, these are issues raised by a multiple number of the reviewers. For example, in the UK and France there is a huge accumulation of liquid high-level waste in a very dangerous situation. Why was that ignored? And also in terms of environmental compatibility, the interim report states that the spent MOX fuel will be reprocessed without any problem but that is not the global consensus. And also, for spent fuel, if there is direct disposal after 1000 years it would be easier to take out the plutonium from there, so it is dangerous after 1000 years in terms of the proliferation. Compare that to plutonium that can be stolen much more easily on ground is meaningless. There is no comparison between them. The two dangers are of a very

different nature.

Page 12 and page 13, these are Mr. Barker's reports, he is not here today.

Page 14 page 15, because I do not have time I am skipping , these are from Mycle Schneider, he made various points in his review so we took the major points raised, so please read this information later when you have time.

On page 16 and 17 we have Mr. Kuepper's, page 18, we have Professor von Hippel, so the summary of their criticism of the Interim Report were shown in those slides.

Page 19, 20 we will discuss later. Is it really feasible that a large number of power plants will have to stop operation by the freezing of the Rokkasho Plant? Our view is that that is not likely, not possible, but I will omit the explanation about that and go on to the last slide.

The Interim Report gave consideration to a moratorium option on reprocessing, and a direct disposal option The point that they gave thought to such possibilities is one step forward, because in the past they said that they are going to do reprocessing and thought about nothing else. And, also we can appreciate that they accepted that direct disposal is much more economical than reprocessing, we now have common understanding on this. However, they have this scenario evaluation instead of a policy evaluation so the output is essentially irrelevant. And, also the evaluation of each of the items is very weakly supported and that is another problem. As a result, the conclusion is not effective. So, our conclusion is that this should be rejected, the output should be rejected, and we need a new organization with fair composition of the members, and with an independent secretariat to reexamine this. If that is not possible for the Atomic Energy Commission, we need a higher-level government organization to do the evaluation from a broader perspective. I think that is one option. That is all, thank you.

(Mr. Kato)

Thank you very much. The Interim Report and the evaluation by the panel and the conclusion drawn by the panel were explained. We are already 10 minutes plus behind schedule but we would like to catch up.

Session 1

Küppers Christian
Hajime Yamana
Yo Fujimura

(Mr. Kato)

We will start three sessions. The first session is a safety and environmental compatibility. We will have presentation from Mr. Küppers, Mr. Yamana and Mr. Fujiwara. I will give 4 or 5 minutes each and if possible I would like to be very brief so that we have enough time for discussion afterwards. Mr. Küppers, could you start?

(Mr. Küppers)

Thank you very much. I want to present some comments to the safety and environmental compatibility. Next slide please. There are two statements in the Interim Report that I want to present to you at the beginning. Next slide please. The first statement to the radiological impacts in the Interim Report says that for all the nuclear facilities, for direct final disposal and for reprocessing and MOX use as well, for all these facilities exist the same radiological limits and therefore there could not be any significant difference and the report also states that doses are much lower than exposure from natural radiation. The second statement is dealing with safety assurance and the Interim Report says that all the facilities have to assure safety to the required standards and therefore there is no difference and Japan lacks technical knowledge in regard to direct disposal. And now I want to comment especially to these statements.

Next slide please. On the left side you see important facilities for direct final disposal. The building is an interim storage, dry interim storage, and the left picture is a picture of the cask standing inside this building. On the right side you see a reprocessing complex, in this case it's Sellafield in Great Britain. Next slide please. Now, one thing is that the interim storage facility has practically no releases of radionuclide. We have experience in Germany for a lot of years in operating such facilities and it was never possible to measure any radioactivity that was released. Next slide please.

Also, these facilities are very strong against accidents even against attacks of terrorists. This means in the case of earthquakes, or an impact by an aircraft that crashes on the facility there is no very large release of radioactivity expected. In the last year a lot of investigations were made in Germany because of the 11th of

September and it was investigated how the impact of the nuclear, terrorist attacks by an aircraft would be and the result is that there might be release of radioactivity, but not a release that would make it necessary, for example, to evacuate people around the facility.

So we can say that this kind of facility, the interim storage, is a very safe nuclear facility, I think it is the safest nuclear facility that exists because even very strong impacts, there is no catastrophic release of radioactivity possible. Next slide please.

At the end the stored spent fuel is put into final disposal. Next slide please. The reprocessing complex has a lot of different facilities, there are also interim storages for spent fuel. There is a facility to reprocess the fuel. There are facilities to clean plutonium and uranium to produce a powder of plutonium. There are facilities to manage waste for example vitrified high-level radioactive waste. And there are facilities to store these wastes. So, this is a very complex facility if you compare it to an interim storage. Next slide please.

This means that nuclear reprocessing plants are the nuclear facilities with the highest routine releases of radioactive substances. This is the case in the European reprocessing facilities and also in Rokkasho. Next slide please. There are enormous inventories of disposable materials, this means of material that can be released in incidents or accidents. Next slide please.

This means that there is possibility of high releases in cases of accidents, for example, fire, explosions, earthquakes, terrorist attacks, and these releases can be higher than releases from nuclear power plants core melt accidents. For example, higher than releases from the Chernobyl accident in 1986. Next. And, the waste of such reprocessing facility must also be brought to a final repository, there is high-level radioactive waste and the waste amounts, if you add all the radioactive wastes, enhanced if you compare it to direct final disposal. Next slide. The plutonium can be reused and this means the use of MOX in light water reactors are as plutonium elements in fast breeders, this means there is an additional risk because fabrication and use of MOX has more risks compared to the fabrication of uranium fuel or to the use of uranium fuel in light water reactors. And now the next slide. The waste that is produced in using MOX is more dangerous and must be put to a final repository. More dangerous means here that there is enhanced heat development in the spent MOX fuel compared to the spent uranium fuel. And there is also an enhanced * * * quantance * * * of special long-lived transuranium radionuclides, other nuclides than plutonium. So if you reprocess the MOX then this problem is not overcome, then you have a second cycle and afterwards you have additional and even worse

waste.

Next slide please. This means the consequences of the scenarios one and two, means that reprocessing is used in the scenarios. The first thing is that much more releases of radioactive substances to the environment have to be expected. Next slide please. And there are much more risks by accidents, more possible accidents, and much more releases of radioactive substances in accidents, especially in accidents beyond the design. And if you remember the statement I quoted at the beginning, if you say that all these facilities have to be strengthened according to the safety standards in the same way, then all the accidents beyond the design are not regarded. This means for example the terrorist attacks make a very, very significant difference between these kinds of facilities, between direct final disposal and the reprocessing pathway.

Next slide please. There are more long-term problems in the interim storage and final disposal. If you make reprocessing as I mentioned more heat production and more transuranium nuclides in the waste that must be disposed of. Thank you for your attention.

(Mr. Kato)

Thank you very much. Professor Yamana please. Thank you.

(Mr. Yamana)

For myself, I am going to talk about safety and environmental compatibility.

At the outset I would like to say that currently reprocessing and recycling road that is being considered and this is to be selected as a comprehensive management measure for controlling radioactive materials and nuclear materials. So removing plutonium or recovering plutonium is just one part of this. The issue is comprehensive management of radioactive material and nuclear material. Third point, on this slide, many people oppose recycling and reprocessing but there is no clear opinion that direct disposal should be chosen. So people deny reprocessing but there is no strong voice for direct disposal. Direct disposal is to bury waste directly in the ground and were at a time when we are not able to make that decision, to take that road. So, I am going to talk about the reactive waste perspectives of reprocessing.

First, one things you need understand in terms of the basic thinking is what to do with plutonium, so this is a plutonium management issue, and what to do with the radioactive waste. So those are two issues that need to be considered. Just thinking about plutonium is not enough. These things should be considered comprehensively. Reprocessing and recycling is where your recover plutonium and you put it in the

management scheme of the fuel cycle and you use part of that and you accumulate it as a resource so it can be used over the long-term.

In terms of the waste management, you remove uranium and plutonium from the spent fuel and the fissile material that really needs to be disposed will be geologically disposed as high-quality waste. So, direct disposal says that you directly dispose of the plutonium and you remove it out of human control and in terms of plutonium, with recycling and reprocessing you combust the plutonium by plu-thermal, so you reduce the volume and also by burning plutonium in plu-thermal it will change to an isotope that cannot be used as a weapon but in terms of direct disposal that is not done. So, there are very different philosophies there.

If you look at the characteristics of the radioactive waste, the left-hand side is direct disposal, the high-level waste that comes out of that, and the right hand side is something that comes out of reprocessing. If you look at the lengths of the waste, if you look at the size, the metal canister will include the full fuel assemblies so one would be 4.76 meters. If you include the full assemblies it will be 40 tons per this waste. And the glass canisters is 6.1 tons and the height is 1.73 meters, this is coming out of reprocessing. So, for a ton of spent fuel if you compare these numbers with the vitrified waste it's 7.6 tons, but with direct disposal it will be 21 tons. So you need to dispose of very large and very heavy material. And, the matrix is the uranium dioxide that is irradiated and it is not uniform, but vitrified waste is very uniform. And also, with direct disposal by characteristic of the fuel, the characteristic of the waste will also vary, but you do not have that kind of disparity with the reprocessing, it is much more uniform. And you remove plutonium so in terms of heat or the alpha radiation, those figures are very different. And with this evaluation, when the area of the geological disposal site with direct disposal compared with glass canisters, it will be larger. That is the result of this evaluation. If you do recycling reprocessing, the low-level waste will increase some say.

So let us look at a numerical quantitative comparison. I have compiled some numbers that have been reported in various studies and this has been normalized per 100,000 tons of spent fuel.

With the high-level waste, as you can see, with the glass canister, it is 89 cubic kilometers. And with direct disposal it is 266. And with weight, 763 versus 8696, so you would be burying much larger much heavier material and with the lower-level, with the operation of nuclear power plants, the lower-level waste is generated in large volumes. And you have pit disposal, subsurface disposal that is 889 km³ and then 27 km³, that is disposal at the deeper depths that would not be different. But, with the

reprocessing you would have 72 for the sub-surface and 79 for the deep, and pit disposal 248 of TRU. So, and subsurface it's 889 versus 889 plus 248, so there is an increase, it's about 20 percent increase in terms of the sub-surface disposal. So, by reprocessing, it does not result in a huge growth in low-level waste its only 20 percent growth in the low-level waste to be disposed in subsurface. In subsurface disposal, economically speaking, it is quite cheap. A very small part of the cycle cost. In terms of safety, you already have this subsurface disposal of LLW from nuclear power plants so, with a slight increase it is not going to result in a drastic difference. In terms of radiation toxicity, the vertical axis is the radiation toxicity of the nuclides and the horizontal axis is the number of years after it has been removed from the reactor. FP, fissile products, typically goes down to low-level in 1000 years. Plutonium, minor actinides, take longer. And all of that is included in the spent fuel. With the recycling and reprocessing, the plutonium and the minor actinides together are shown. This is what we are aiming for. And if we are to recover this and store it on ground put it within the nuclear fuel cycle and manage it in that way, then it will be able to dispose only the fissile material. So, 1000 years will be a key number. 1000 years we have direct disposal and the number of years that we can ensure the safety of our engineering technique is 1000 years. With the current technology, with minor actinides we cannot recover, we would just put plutonium on the ground, and the others we would dispose of them. That is where we are starting. And the important thing here is that recovering plutonium, keep it in the fuel cycle, manage it and then we will consume it or if we have a fast breeder reactors then we will combust it, we can increase plutonium, so we have such different choices that we can make in the future. So, the difference is that plutonium and minor actinides should not be managed on the ground so that the choices can be made later or should they be buried immediately under ground. So, that is the difference. Just look at the left-hand side here. UOX is where directly disposal of spent fuel. In 20 years, plutonium and the minor actinides nuclide composition is shown here. PU is plutonium. So, below the yellow line is plutonium. With the plu-thermal, plutonium will be combusted so you will have less plutonium. With direct disposal you will have that full amount of plutonium. And, plutonium 239 and 241, these are very fissile plutonium they will be reduced, but with the plu-thermal, we cannot remove them entirely, we need a fast breeder reactor for that. With plu-thermal we are able to reduce to a little less than half. And, if you look at the isotope composition of plutonium, as you can see here, plutonium 239 and 241 together is only about 40 percent. The plutonium combusted in plu-thermal is of isotope structure cannot be used in weapons so it degrades the plutonium, that is the

effect of burning it in plu-thermal. So, radiation toxicity comparison is very important. Toxicity is the vertical axis and the horizontal axis is comparison between plu-thermal and direct disposal. And, not a significant difference between the two, that is the conclusion. If you do [a] direct disposal [of] the 241 plutonium that is the fissile nuclide [which] has a half-life of 14 years so, [then it will be] converted to americium 241 automatically which is very toxic. So direct disposal takes combustible plutonium and changes that, transforms it to very toxic americium 241. In plu-thermal you will burn the plutonium, and in that process americium and the curium, toxic substances will be created and curium will now have a half-life of 18 years so, over the long-term there is not much difference. In terms of radiation toxicity, there is no difference between the two scenarios. So, using the fast neutrons is one way that we might deal with this because if you use fast neutrons you can burn these kinds of nuclides. So, fast breeder reactor technology is important in that regard. Let us talk about safety. Earlier there was some talk about safety, basically my view is that the safety of nuclear power plants in their facilities should be considered from a risk perspective and the risk is calculated by the inherent hazard, that is the amount of danger, multiplied by the possibility of exposure. So, the probability that it will come out and expose the public, so it is a multiplication of the two. So with a higher hazard you need to lower the probability to lower the risk. If the hazard is small, then the probability can be a little higher. Evaluation of the risk in general industry are in nuclear industry is very important because risk evaluation is not done sometimes unnecessary investment is made or people focus on the not so important issues. So, when you consider risk you need to clarify what is the endpoint. In risk theory, the endpoint is the outcome that you absolutely want to avoid. And in the nuclear industry, that is that the exposure of the residents does not surpass 1 mSv per year in ordinary state. And, even in the very rare case it does not exceed five μ Sv per year it says, but it should be per incident. So, that should be the endpoint. These are very safe figures. But that is the endpoint, and we should consider risk and the probability in that regard. Now those who are critical of reprocessing, they have this tendency that they overemphasize the uniqueness of the hazard. Well radioactivity people feel uncomfortable with that. I can understand that. But, radioactivity exists in nature and it's wrong to just emphasize uniqueness of the hazard of radioactivity. And, they have this very strong repulsion against processing in liquid form. I have experience of reprocessing at the university I do experiments using radioactive material. But, I do not see any problem treating it in liquid, there are some cases where it's less safe but there are circumstances where the solid form is more dangerous. Accumulating spent

fuel, that is not safe of course. Changing that to liquid form and then immediately putting it into solid form is reprocessing. So, you should not be worried about this interim form of liquid. And, also people are critical and use expressions like “irreparable” and they deny the engineering responsiveness and we think that engineering has a lot of capability to deal with various issues. Also, those who have promoted in nuclear energy of also had problems, they made an explanation that there is absolutely no risk and those people should understand that that was a mistake. And, also there has been some problem with the quality assurance of the facilities and that needs to be corrected. Now, in terms of the release of radioactivity and safety of accident and terrorist issues, I need to skip this page because of time. In terms of the risk of radiation release, this shows the natural radiation exposure and exposure by reprocessing. Rokkasho plant has evaluated that this amount of exposure, 22 μSv of which 5.3 is external exposure. External is coming from outside the body being irradiated by radiation. And, internal exposure is by taking in radioactive material inside your body you have internal exposure. So, you have about 14 internal exposure, 14.6. External, 7.4. Of that concerning internal, carbon and tritium are the major factors. If you look at the world average of natural radiation exposure, its 2400 μSv per year. It is not that high in Japan. It's less than 1000 mSv . Just by sitting in this hall we are receiving that kind of exposure. So compared with 1000, 22 is quite low. And, of the natural radiation you have the inhaled exposure and food exposure, so uranium, radon, toron by inhaling that gas you have an overall average of 1256. In this country, let us say it's half. So, its 600. So, compared with that kind of the natural exposure, it is 22 at Rokkasho. So, this is within the environmental variability, especially in Aomori there is a paper that explains the average natural exposure of radon. This is a very meticulously researched paper, very highly reliable. In an ordinary work environment you have 390 μSv per year. That is in Aomori prefecture, just from radon. You will add other radiation, but this is quite, you can see that, it's quite small compared with the natural exposure. Now, earlier there were some talk about the possibility of exposure, but at the Rokkasho plant they have considered more than 1050 abnormal transient and beyond abnormal transient, AT and BAT. So, people say that safety measures have not considered the various accident scenarios. That is wrong. Various different types of events have been considered. And, so that should lead to the reliability issue. Thank you very much.

(Mr. Kato)

We are much behind time but, professor Fujimura, please.

(Mr. Fujimura)

I'm afraid that I do not have time left but I would like to talk about safety and environmental compatibility. What the Interim Report says is that, as what Mr. Goto has introduced, there is no significant difference between safety of reprocessing and direct disposal and potential priority of reprocessing in environmental compatibility. The word environmental compatibility is something that I heard for the first time. The interim report says that separation of plutonium and uranium by reprocessing results in reduced potential toxicity of high-level waste down to 1/8 in 1000 years later and reduced volume of high-level waste down to 30 to 40 percent, which all sound very good. But, as Professor Yamana said, even if you do reprocessing, utilization of plutonium in light water reactor as MOX fuel does not make the volume and toxicity of high-level waste go down that much. My argument is that the policy should not be made based on such biased discussion. So, what the Interim Report ignores is that in reprocessing, the use of MOX fuel in reactors and disposal of this spent MOX fuel. Compared to spent uranium fuel, spent MOX fuel has five to 10 times more plutonium and TRU which will increase toxicity and heat. This increased heat makes the area of the final repository larger. Of course the absolute amount depends on whether spent MOX fuel is directly disposed of or disposed of after reprocessing, the toxicity and the repository area becomes closer or comparable to once through option. Furthermore, compared to high-level radioactive waste, low-level waste of reprocessing could have more impact in terms of safety of disposal. This slide depicts the situation. In the direct disposal, the whole spent nuclear fuel becomes the waste. In the reprocessing, plutonium and uranium are removed and remained part is buried as vitrified waste. The Interim Report compared just these two. But plutonium is used as MOX fuel which would be 10 percent of the total electricity generation by nuclear power in Japan. And then we have this spent MOX fuel with increased amount of TRU and plutonium. This should be taken into account otherwise you can't talk about environmental compatibility properly. And, this is a graphical representation of toxicity against the time after discharge of spent fuels. The toxicity for direct disposal would be like this. If reprocessing is done four years after discharge, the toxicity would go down to this line. But, by adding the toxicity of spent MOX fuel reprocessed four years after the discharge, the total toxicity will rise to the yellow line. And the current plan says the MOX fuel is not going to be reprocessed in next 45 years. So the total toxicity becomes much higher as shown by red line. And the purple line indicates the total toxicity when spent MOX fuel is disposed directly. In this case, the total toxicity is

not different from the non-reprocessing case at all. In any case, the total toxicity in reprocessing option is not as low as 1/8 at 1000 year later by considering the contribution of spent MOX fuel. Professor Yamana talked so much about the radiotoxicity, but radiotoxicity corresponds to taking radionuclides with the composition in the radioactive wastes. And, actual radiological impact of disposal of radioactive waste is determined by how much and what types of radionuclides are in the inventory, their half-lives, their mobility in underground water, quantity taken by human in the environment and the radiotoxicity of each nuclide. Plutonium is not so mobile in underground water, so even if plutonium is taken out it won't increase the long-term safety of disposal. This graph compiles the assessment done by JNC, FEPC and JNFL. As Professor Yamana said, the engineered barrier could be destroyed 1000 years after the disposal and then radioactive substances could be released. This graph shows the expected exposure dose for such occasion. This line is the case for geological disposal of vitrified waste. Here, the contribution of plutonium-239 is very small. But even if it is not reprocessed, the contribution of plutonium-239 becomes only that much. Still its contribution is very small. So, in terms of disposal safety, plutonium is not a determining factor. Once the reprocessing plant is operated, low-level wastes other than high-level wastes are produced and some parts of them are considered to be geologically disposed into 500 to 1000 meters deep. This line shows the exposure dose resulted from such waste and it is much higher than the vitrified high-level waste, due to the contribution of carbon-14 and iodine-129. Furthermore, this line is the exposure dose for sub-surface category of the waste from reprocessing plant disposed into concrete pit, as Prof. Yamana mentioned. This is also much higher than the vitrified high-level waste. And, this is the exposure dose caused by middle-depth category disposed into 100 meter depth. So, compared to high-level vitrified waste, so-called low-level wastes from the reprocessing plant have quite large exposure doses. And, as for direct disposal, the exposure dose is close to geological disposal of low-level reprocessing plant waste. It is true that the waste form is larger and bulky and is more difficult to handle but, in terms of radiation exposure source, it is only one source. Finally, this line depicts the exposure dose of 20 μSv per year, as Prof. Yamana mentioned, for operation of reprocessing plant. Although it is lower than natural radiation exposure but in terms of safety there will be increased probability or chance for radiation exposure in reprocessing option. Also, in terms of environmental compatibility, reduction of radiotoxicity is too emphasized but from the perspective of safety of disposal it is not necessarily true that reprocessing is more favorable. And, the next slide is the summary of what I said. The MOX

fuel and other waste should be all included for lifecycle analysis in order to discuss these policy options and the interim report may be heavily biased toward reprocessing. Thank you.

(Mr. Kato)

Thank you very much. Well with the remarks from three people we have already used quite a lot of time already, we are already 20 minutes behind schedule. Sorry for my bad chairmanship, but with the three presentations we have heard what are the issues concerning safety. I think it has been made very clear by these numbers what the issues are. Professor Yamana talked about the risk being hazard by exposure or probability and if I may make a general summary, please correct me if I am wrong, it seems that how to look at the risk or hazard [is the issue]. I think within the same kind of explanation, the nuance was quite different by the two speakers. And, Mr. Küppers said that with various processing there is more opportunity for hazard or risk, so the frequency of risk increases. That how I took his talk. And, with a higher frequency of danger arising, with what Mr. Fujimura said, in addition to the high-level waste, with low-level waste, that is also quite dangerous if it is in larger volumes so, how to think about that together is I think the issue. So concerning safety, each of the speakers showed the numbers and later we can perhaps discuss this further. But, what I would like more explanation about this, the words “plu-thermal” and “fast breeder reactor”. These two words were used. How are they related to this issue? And, this fast breeder reactor, future feasibility going forward. I think that would also impact the scenario. So in the discussion I hope that will be taken up.

Session 2

Frank von Hippel
Tomio Kawata
Tetsunari Iida

(Mr. Kato)

So, I think with that we need to move on to the next session, it is already 20 minutes behind schedule. Perhaps we will not have time to have free discussion for each of these three sessions, but within five minutes please may I ask each of the panelists to make their initial comments. If we have time we would like to have some discussion along with the previous three speakers. So I would like to ask the next three speakers. Professor von Hippel, please.

(Mr. von Hippel)

The quantitative cost-benefit analysis in the Interim Report is of the economics, which are found to be very unfavorable to the plutonium recycling, the economics. The arguments made in Interim Report are qualitative when they are discussing the advantages of the plutonium recycling and they are selective and they ignore obvious stronger arguments to the contrary. The information that you are getting from this panel is I think much better than information that you are getting from the Interim Report in terms of actual analysis. In my discussion I will focus on a summary of my conclusions, my own conclusions, in which I emphasized international implications of Japan's decision. In the international context, Japan is the only non-nuclear weapons state that separates plutonium and soon will be the only non-weapons state that is recycling plutonium. The nonproliferation treaty weapons states have stopped their reprocessing to obtain plutonium for weapons. The United Kingdom is abandoning commercial reprocessing and France, India and Russia are the only weapons states that are still committed to reprocessing, although China is considering it. Now, Japan's policy is, with regard to plutonium, which it presented to the IAEA in 1997 was that Japan will not accumulate plutonium beyond the, separated plutonium, beyond the amount required to implement the program. That is the principle of no surplus plutonium. Unfortunately Japan is not been able to live up to this policy. At the time it announced its policy it had 20 tons of separated plutonium. In 2003 it had about 40 tons and the amount is somewhat greater today. Although this, most of the separated plutonium, except for five tons, is stored in Britain and France. But now if Rokkasho is operated Japan will be separating out an additional eight tons of

plutonium domestically in Japan, enough plutonium each year for 1000 Nagasaki bombs. Now, the situation has changed. When Japan launched his plutonium program in the 1960s and 1970s, it believed that uranium demand would soon exceed supply, that plutonium breeder reactors would soon be economic and that power reactor plutonium is not weapons usable. That is what Japan's nuclear policymakers believed when this program was launched more than 30 years ago. But today, Japan's government and nuclear industry know that plutonium recycling is not economic even if the cost of the reprocessing plant is excluded because of course the reprocessing plant at Rokkasho is already built. Second, they know that Japan's plutonium is weapons usable and they also know that we have a danger, much greater danger, that we're worried about today about the possibility of the theft of plutonium and the use by terrorists of that plutonium. Finally, and I emphasize this, Iran is citing Japan's example and asserting its inalienable right to facilities that would give it nuclear weapons options. So Japan's example is very influential as the only non-weapons state's reprocessing in the debate over nuclear proliferation in other countries. Now, the alternative to reprocessing is spent fuel storage. Spent fuel is dangerous in the first five years after it is, especially in the first five years after it is discharged from a reactor. Then it must be stored in spent fuel pools to take away the heat at the reactor sites. In any case, it cannot be removed in less than about five years to be reprocessed in any case. Now, older spent fuel can be stored in dry casks as we heard from Dr. Küppers, and that storage is extremely safe. Now, what will happen in reprocessing is that high-level waste, and plutonium will be separated and then stored separately because in fact Japan has so much separated plutonium already that it cannot use the additional plutonium that would be separated at Rokkasho for probably decades. So the question is why not leave them stored together in un-reprocessed spent fuel. The security reason for doing that, for storing plutonium with the fission products, the very highly radioactive fission products, which produce a gamma ray field around the un-reprocessed spent fuel is that that gamma ray field will protect the plutonium in the fuel from theft for more than 100 years. This is much safer way to store the plutonium. Thank you.

(Mr. Kato)

Thank you. Now, Mr. Kawata, please start.

(Mr. Kawata)

In the future, how will people acquire electricity? That would be a key question. As

you can see from newspaper recently, the crude oil prices have topped at seventy dollars per barrel and this shows a little bit outdated, but for the past ten years on the average, every year six billion barrels new reserves or discovered, but actually twenty billion barrels are consumed every year. So, the resources have been depleted. And China, who has been the sleeping dragon, is now about to consume a lot of energy just like a king snake.

If you look at natural gas in Japan, the prices are doubled, and in the US, it has been quadrupled even though they can use pipeline for transport. So, the fossil fuel has a limitation, and that is the fact that we have to come to terms with.

On the other hand, for the renewable energy, generating power with renewable energy is also important. If you can take a look at the left green bars, the wind power has been increasing in the world. That is indicated. And how much the renewable energy is contributing to the power generation is shown on the right, and the red line shows the total power generation of the OECD member countries. Out of the total power generated, how much is accounted for by renewable energy which is about 20%. But actually the natural energy or renewable energy is not catching up with the pace of the increasing demand. So, the proportion is decreasing. And actually, new energy – wind power or solar or photovoltaic power – how much they are contributing. Actually, their contribution is quite minimal as you can see in this graph. And, of course, this has to be enhanced going forward, but how much can we expect out of this. And especially, how much a stable basic load can be met with this type of energy is a question. So, if you look at this history, then this blue line shows the population growth, and red portion shows how people have used fossil fuel after the industrial revolution.

Up until now, only for a very short period of time, we are about to deplete the fossil fuel. Then, what should we do? We have to keep saving energy, and on the other hand, we have to enhance the nuclear energy and renewable energy. So, nuclear power is not a temporary means for surviving energy, but it has to be permanent. I looked at the fossil energy price increase earlier, but this green line shows the cost evaluation from the interim report for reprocessing option and direct disposal option. They point seven yen difference in unit cost of generation. So, direct disposal is less expensive in that regard, but nuclear power represents only one third of the total generation, and the rest is from fossil fuel. And actually, the red dots show the fossil

fuel evaluation in 2002, and coal prices have actually more than doubled. The green one has to be accepted. The very small difference between direct disposal and reprocessing in terms of cost, and maybe insignificant compared to the total picture.

The government has decided to continue with reprocessing, but if you were to decide stopping reprocessing, then interim storage facilities have to be increased. Rokkasho is already in place, and the base ***** assumption that Rokkasho would start operation. 3,000 tons for the moment, and ultimately 5,000 tons of spent fuel could be accepted by the interim storage facility. But once the reprocessing plant is up and running, only 1 or 1.5 additional interim storage place will be needed in Japan. But if the reprocessing is stopped, then the interim storage facility in Aomori will have to be abandoned because reprocessing is done quite nearby and that is the basic prerequisite for the interim storage in Aomori. We will have to have ten more interim storage facilities built, and how realistic would that be is a question.

Professor Hippel said that the as a non-nuclear weapon state, Japan would be the only one who is doing reprocessing. But if you look at the total power generated, 46% is from those countries who are involved in reprocessing and another quarter is undecided and the remaining quarter is from the US. What this means is that the major nuclear power generation countries are for reprocessing. And actually, the US is just about the only country who is opted for direct disposal. And the most of the smaller countries are for direct disposal because there will not be so much spent fuel to be stored.

And the US is now in trouble because Yucca Mountain final depository has been decided on, but actually, this will be ***** capacity for the spent fuels to be generated by 2015, and actually for another nine more facilities will be necessary. In the US, it will be very difficult for the US to actually build a new final depository, and discussion is ongoing in the Congress. So, the US is now considering the other options than direct disposal, looking at new initiatives.

So, the major nuclear power countries looking at various options in the future, what they are mainly focused on are reprocessing including the US, even. And the nuclear power which can be relied on permanently will be, in my view, a fast breeder reactor. And this is a comparison.

In case of a fast breeder reactor, the uranium which is already stored underground can be utilized for generations, and as for the waste issue, by recycling them, especially high level waste repository which is quite difficult to site, will benefit because space can be efficiently used. But for the light water reactor, the uranium has to be always dug in mind and most of it is disposed. And 95% of the resources, the uranium actually can be used, but only 1% is actually used for energy supply. This is quite unrealistic and difficult to continue option.

And non-proliferation is the issue for reprocessing that is what has been pointed out. In the US, there have been two major reprocessing plants in Europe or 25,000 tons have been reprocessed so far. And as a result, in the heart of Europe, the MOX fuels are loaded to thirty-five light water reactors, and 2,000 tons of MOX fuels are transported from one place to another. And there has been no incident of terrorists' attacks. In the industrialized countries, it has been demonstrated that the physical protection can be properly done. Also, in Japan, we are trying to produce the MOX fuel, and IAEA has done a very strict investigation on Japan. And last year, as a result, as for the nuclear fuel cycle business and other nuclear activities, there is no sign for the nuclear proliferation. And Japan has been given a special treatment as an integrated safe guard. And this has been the first for any countries with nuclear power generation. In September last year at IAEA executive meeting, Secretary General El Baradei said that there is an increased risk for proliferation in the world, and he talked about Japan.

(Mr. Kato)

Well, Professor von Hippel was quite brief, so I would like to be fair to everyone. Mr. Kawata.

(Mr. Kawata)

Yes, in Japan, for reprocessing, what would come out is the MOX fuel. Plutonium oxide would come out from European reprocessing plants. MOX fuel cannot be used for nuclear weapon directly. So, in terms of nuclear proliferation, it has been a safe guarded.

(Mr. Kato)

Sorry to cut you in early, but we would like to move on. Mr. Iida, please.

(Mr. Iida)

For myself, I'm going to talk about energy security mainly. From ICRC report, I would like to explain to you what our logic is. From Fukushima Prefecture, there was a report, earlier, about the Interim Report, and this will be in page 3 of that Interim Report. Paragraph 2, two or third line, concerning energy security supply stability, and in terms of saving resources, 10 to 20% savings of uranium can be expected. So, with that they say that there is an energy security benefit. That is the Interim Report. In contrast to that, if you use your common sense, the impact of saving uranium in your country and having energy security with oil going about seventy dollars – some expecting to go to 100 dollars. And 10 to 20% savings of uranium. These two things have nothing to do with each other. Basically, when the oil prices go up, the main impact is in international uranium price, but ultimately, how that impacts the domestic uranium or energy security. In a short term, there will be an impact from the energy prices to the economy. You do not need to think about the supply stopping from oil, but there will be economic impacts. And the second point is the energy **backing** be used forever, eternally. By doing *pluthermal*, you are saving 10 to 20%. That is completely unrelated to that issue of having eternal energy. Now the second point. If saving uranium resources, thus contribute to energy security although we do not think it does, even if we assume that, the Interim Report still does not have good logic because they are talking about the necessity of reprocessing plant taking out plutonium and burning that later. Do you really need that kind of cycle? While uranium is cheap, why don't we just purchase more uranium and stock pile of uranium, or we can try to lower tail uranium, so that the more uranium can be harvested from uranium ore. I think that would be more cost effective. So, there are several options, but those are ignored, and the nuclear fuel cycle is to be pursued. That is where again logic does not make any sense. And there is no comparison with other forms of energy, and there was diluted statistics of new energy from OECD earlier. In terms of renewable energy, many countries do not have adequate deposit, so, it is very foolish to include those countries to say that the new energy cannot be relied on.

If you move two pages, the most advanced nation in renewable energy is Germany amongst other advanced countries in Europe. In 1997, they have 4.7% renewable energy. It is over 10% now of electric power, and the governments targeted as 12.5% in 2010. They will overshoot this target for sure. This shows wind power. But in fact, there is biomass and photovoltaic. Last year's installation capacity surpassed that of Japan, and in 2020, 20% share is expected to be supplied from renewable

energy in Germany. This creates or has already created 130,000 employment, one trillion yen of economic impact, and given birth to a new industry. And in other countries, too. UK by 2010, 10%, 15% by 2015. So, they set high goals, and if those policies are implemented appropriately, it has already been proven that the ratio can increase. Certainly as Mr. Kawata said, if the fast breeder reactor is realized, and within the current energy economic system, if the capital markets that should appreciate that and could be introduced in a way that they could be appreciated by the capital markets, it could be a viable option. But in 2050, how much of the energy share in Japan could come from FBR. We only have to think that. And in 2015 or 2020, in a short or long term span, how much difference would the recycling policy create. So, in the current capital markets, which approach has a lower risk, and which is the more in line with technical trends in the world. That seems to be clear. I forgot to include graphics – two examples, two case studies. IAEA in 2003 put together energy investment outlook toward 2030, and by 2030, (in) the energy investment, 50% will be in renewable energy – that is about eighty trillion yen. 200 trillion yen, in total in the world, and about a half of that will go to renewable energy. That is the outlook. If you look at the actual history in the past several years, they actually constructed the power sources. I do not have the accurate numbers with me. But the renewable energy and distributed power are increasing rapidly, and the nuclear energy has been dwindling over the long term. I did not bring the graphics to show that. But so you see that trend. So, in terms of short term economic impact, the Interim Report does not have a good logic, and in the long term, there is an alternative technology, that is viable, which is not included in the Interim Report – comparison that is where again their logic breaks. In concerning the non-proliferation, Frank's presentation will cover this, so I end at this time.

(Mr. Kato)

Three presentations were made on the topic for the Session 2. Mr. Iida, himself, contrasted his arguments with those of Mr. Kawata. So, the logical rational behind both arguments may have been made clearer. Mr. Kawada said recycling is a world trend, and he shared with us the approaches by various countries. And, at the same time, in interim storage facilities will be required in so many number. And the nuclear power stations siting is a quite difficult recently, and how realistic would it be to build so many interim storage facilities. And, on the other hand, fast breeder reactor was raised again the economics and feasibility of fast breeder reactors should be looked at in the next session. Professor von Hippel talked about Japanese

plutonium program, when it was launched. The prerequisites were quite different back then. And that is what he said. If it is true, then the policies will have to change accordingly. And whether the policies have changed, and are changing accordingly, and those are the some of the points that I would like to have discussion on in the next session. It is twenty minutes past three, and actually we were supposed to have a fifteen minute break from three o'clock. But we would like to take a five minute break at this time, and if you go to the restroom during the five minute break, and if everybody goes to the restroom it would be too crowded. The discussion will be quite heated, but I would like you at the same time to enjoy and feel relaxed. I would like to take a five minute break at this time. Thank you.

Session 3

Mycle Schneider
Youji Uchiyama
Takeo Kikkawa

(Mr. Kato)

Ladies and gentlemen, we would to restart the session. If there are people outside of the door, and if you see them, please come back to your own seats.

There may be some several people still outside of the room, but we would like to go ahead and start Session 3. In this Session, we look at economics of nuclear fuel cycle, especially focusing on the policy change cost. We would like to ask Mr. Schneider, Mr. Uchiyama, and Mr. Kikkawa. In this sequence, five minutes, each. And after that, there will be thirty minutes saved for discussion after having comments from each panel member for about two or three minutes. I would like to just solicit the comments that you definitely would like to make at this point of time and rather focus more on free discussion. So, we would like to start with Mr. Schneider. If you can be as brief as possible, that would be appreciated. Thank you,

(Mr. Schneider)

Thank you very much, Mr. Chairman. It is a great honor to be here today, and I thank you very much for this invitation. Let me make just a very brief comment. The only thing I regret is that we do not have the possibility today to have a direct discussion with the authors of the Interim Report. And I think I regret that a little bit because I think that would have been the ultimate objective to confront our analysis of certain problems and inconsistencies that we have identified in the Interim Report with its authors.. So, it is the only thing I do regret.

Now, the Interim Report, as we have heard, goes through a large number of different criteria and several scenarios. I do not wish to go through all the details. I have decided to just make my comments on one single point. And that is the question of energy security and the background of economics because the panel is supposed to make comments on economics. What I felt with several previous speakers is that they are not people that are members of the international chokei review commission is that to some extent there is some theory being presented. How it *could* be, how fast breeder reactors *could* play a role, how nuclear power *could* have a role, etc. So, I think it is very important to look at the reality first. The Interim Report on the

economic side, as it has been said, recognizes very clearly that there is an economic disadvantage of the plutonium economy. But there is a systematic bias in the analysis in favor of the plutonium option. One example is that it vastly overstates the potential impact of the plutonium economy on energy security.

And I wish to make the illustration of a real case, not a theoretical case, a real case, and that is the case study of France. The case of France is the only one in the world, that actually has a full scale reprocessing program, that has a full scale recycling program, reuse of plutonium in fast breeder and light water reactors. So, it is the only reference that actually exists. So, it is very important to have a look at this case. In France, nuclear power plants provide 78% of the electricity. That represents 42% of the commercial primary energy. That means the energy that is actually going into a power plant. You might know that a nuclear power plant is actually a very inefficient way to make use of primary energy. Two thirds of the energy that is contained in uranium is actually been lost in the form of heat in the transformation process. So, there is a big difference between the primary energy share and what is called the final energy share, that is the energy that is actually being delivered to the consumers. That is really what we are interested in, how much energy that we use is provided by various sources and various technologies. And as you can see less than 18% of the final energy in France is actually being provided by nuclear energy.

This might come as a surprise to some people here in the room because people always keep the impression that France lives off nuclear energy. In fact, over 70% of the final energy is being provided by fossil fuels – oil, gas, and coal. We are talking about France, here. OK? So, even today, – these figures are for 2004 – the vast majority of the energy comes from fossil fuels. All of those are imported, and in fact, all of the uranium is also imported. In other words, 70% plus 18%, that is close to 90% of the final energy has to be imported into the country. Now, which role plays plutonium in that current scheme? Currently, plutonium provides less than 10% of the electricity. It provides less than 4% of the primary energy, and provides less than 2% of the final energy.

Now, if you adapt that to the Japanese case, it is very clear that under any scenario that I have seen so far, whatever favorable it might be, it would be largely less in the Japanese case than in the French case. In other words, the role of plutonium, the potential role of plutonium in the final energy use would be less than 1%. So, this is what we are talking about. Less than 1%. So, to say this has a huge impact on energy security is a misleading statement. Furthermore, it took France, twenty-five

years to absorb roughly 40 tons of separated plutonium. Now, this is less than the current stock pile of Japanese plutonium. Furthermore, those 40 tons were only about half of the entirely separated plutonium at that given time. Furthermore, for obvious reasons, therefore, the plutonium owners, which are the French state utility, EDF, the owner allocates a zero value as a book value in its accounts to its plutonium stocks.

So, this is only one example of numerous insufficiencies in the Interim Report, and I want to leave with it is because we have very little time, but I want to make some general conclusions. This example illustrates kind of a general scheme that goes through the Interim Report. It is a heavily biased evaluation, which lacks credibility. And I think, as a result of that, one should profoundly rethink the methodology of analysis. And the second point is the lack of response to an external review scheme, external review can mean ICRC, it can also mean other experts, other academics that can be NGOs, people that review this kind of document. This kind of review, if it is not taken into account, the lack of response will undermine the quality of policy guidance given by the Japan Atomic Energy Commission and the long term nuclear plan. So, this means one should redefine the role of independent experts, in particular, in this field in Japan. And the last point is a debate that does not allow for all participating parties to influence its outcome. In other words, if I organize the debate and I know upfront whatever the various parties will say in the debate, it will not have any impact on the outcome of the decision making process, it means that it is not democratic. And it also means that that process risks to sacrifice collective benefit to short-term State interest or corporate profit. In other words, I think a profound reform of the decision making process in this area would be welcome. Thank you very much for your attention.

(Mr. Kato)

Mr. Uchiyama, please.

(Mr. Uchiyama)

We have distributed the Japanese version of the slides, but since we have foreign panelists, I have prepared English materials here as you know of the power generation in Japan where you will see the trend here from about around 1970s. Nuclear power has an increased share, and now it is a little over 30%. In the future, it is expected to go to about 40%. If you look at the trend of the current construction, that is what they expected. If it reaches 40%, it will be about the level of the base load of the power

generation capacity. So, that is the level that we are targeting with nuclear energy. So, how has this impacted Japanese economy? There was a talk about the energy security, and economic security is also important in order not to rely too much on fossil fuel. We look at the input-output analysis, and you saw GDP growth rates in the line graph, and how much fossil fuel is consumed to create that GDP. So, we look at the input-output analysis past thirty years. After the oil crises, the impact of fossil fuel on the economic activity has declined. We see coal, oil and gas. And the reason is that energy conservation technology has been developed, but at the same time, the development of nuclear energy has lessened the reliance or the impact of these fossil fuel to the economy.

Now, the current long term plan has been studied in the council, and some people say that their logic is shortsighted, but that is not true. We have the energy basic law, and we have the energy basic plan. At METI, there is the Advisory Committee for natural resources and energy, and they have put together scenario for 2030. It has been studied for many years, and based on that scenario, the current trend of economic evaluations are being made.

Needless to say, the energy policy of Japan, basic objective is stable supply of energy that is energy security. And then, compatibility with environment, that is to be positive toward fighting global warming. These are not short term issues, but these are for our future generations. We need to think of policy that would benefit future generations.

Having said that, we are living now in our generation, and so we need to have that market perspective, too. So, the economic externalities, how it is included in the evaluation analysis is one of the major issues in studying the energy issue. In terms of global warming, as you may know, the amount of CO₂ or greenhouse gas exhausted per 1 kwh is compared by various power sources. The three on the left hand side, there are fossil fuels – coal, oil and LNG. Over to the right, you have the natural energy and nuclear. So, renewables and nuclear energy contribute greatly to preventing global warming. This kind of analysis has been done in many countries with the similar results obtained.

And why reprocessing or direct disposal, as is written in the basic plan? Our basic policy is to pursue reprocessing with safety in mind, but we need to think about

economic situation changes and lessening demand on the uranium. So we should reevaluate whether we should continue with the reprocessing. But unfortunately, the vitrified waste out of after-reprocessing, we have an experience with past twenty years. But concerning direct disposal we have no accumulation of knowledge. So, this is not a direct comparison, but a relative comparison with the disposal of a vitrified waste. And where this would be disposed, it will be 500 meters if it is a soft rock. If it is hard rock, it will be 1,000 meters. So, there are two methods that were studied.

These are the *cases* that were studied for soft rock. There are three cases. The amount of the assemblies in canisters, it could be two or four. Case 3. It *is to* be disposed in two different sites. With hard rock, the number of assemblies in canister is set at two, and the number of sites is one or two. Detailed diagrams are shown. Because of time, I would skip over the explanation. Certainly, this is a long term issue, so how long the timescale should we study was discussed. And the waste that we have or should be disposed of during our lifetime, during our generation, and we should not pass it on to the future generation. That was the basic principle. So, for the 300 years, those that are rising sixty years that should be studied for *in terms of* impact for the 300 years. And this output, this is a cost of direct disposal in the soft rock, three cases, some point 8 to 9.5 trillion yen. For hard rock, it would be *5.3 trillion to 7.3 trillion* yen. So, per ton of fuel, you see the cost on the right hand side. We have a discount rate also included. Discount rate is used as a parameter. As a result, if you compare the results of the Japanese exercise with that of other countries, you see the value from the Japanese studies very high. This time, it was not an absolute but a relative comparison. If we compare the absolute values, quite high, maybe currency, exchange rate issue and also the construction cost is higher, and because of earthquake, the seismic design as cost. There are various reasons, but cost in Japan is high. We need to work hard to reduce this cost.

Ultimately, the fuel cycle cost is what needs to be compared. So, there are the front-end and back-end factors, and those costs are calculated with direct disposal within a range. It would be the total cost of *121 - 206* trillion yen— is that right? And if you look at yen per kwh, it would be 0.19 to 0.32 yen. If you calculate the fuel cycle cost it will be 0.9 to 1.1 yen. With the reprocessing this would be 1.6 yen. So per kilowatt hour 0.5 to 0.7 yen, more expensive. This does not include the cost for policy change. If we were to close the Rokkasho Plant, the difference will shrink by 0.3 yen and some people said that it should not be included. But for the utilities

companies if they do not do reprocessing, they are going to have to build new thermal power plants because the nuclear power plants will have to be stopped. In that case the economics will be reversed. But for this study that portion was not included. 0.2 yen, that was the Rokkasho Plant. That is already paid. So, that is sunk cost. It will be some costs when it is recovered, so it needs to be included. If you compare that 4.7 to 4.9 for direct disposal reprocessing 5.2. So it is 0.3 to 0.5 yen difference per kilowatt hour. So how much of the burden is that per household eight hundred yen per annum. So in the future, over the long term, we can have a plutonium neutralization program that leads in the future to the FBR. To develop technology that will lead to such a technology in the future that amount of burden is not that large. Compare with other power sources the number is changed by the way you calculate this, whether you calculate this with the actual life or the legally prescribed life the number will change. It is difficult to choose which number, but apparently with the calculations that have been done. Whatever calculation you use nuclear is as economical as thermal and cheaper with the longer life. This is calculated twenty dollars per barrel. So with the current surge in the oil prices• coal prices, clearly nuclear is advantageous in terms of cost. In economics of nuclear power plants the characteristic is that uranium accounts for only five percent of the total cost. So even if it goes twice it will not impact the total cost. But with fossil fuel it accounts for forty to seventy percent. So if those prices double, that impacts the energy cost essentially. We have that kind of inherent cost ability with nuclear. In terms of biomass, it is nine to twelve yen wind farm nine to twenty-four yen. With photovoltaic forty-six yen to seventy yen in the seventies depending on the site. With the renewables compared with fossil fuel or nuclear energy rather difficult to compete from the economic perspectives. We need to understand that the renewable energy is being developed. Japan is trying to aggressively introduce such energy while we are working hard to try to introduce, but no matter how hard you try, in 2010 it will only account for two percent of the total energy as a major source of energy we can not account on renewable energy. We do not have that prospect at this point of time. If you look at other countries some countries are most suited for renewable energy. Those countries should aggressively try to utilize that. I think that is important. Thank you very much.

(Mr. Kato)

Thank you. Professor Kikkawa.

(Mr. Kikkawa)

Yes, I am Kikkawa. I have not prepared any PowerPoint presentation. Sorry for that because a panel discussion is supposed to be for a discussion. I thought I would ad lib most of the time and I wanted to speak in some lights without the darkness for PowerPoint presentation. If in this discussion it is not for a discussing for or against nuclear power and it is not the forum where you decide whether reprocessing should be or the final disposal should be taken. This is the place where we have to discuss whether we should go ahead and start operating the reprocessing plant. As a member of ICIC I may be an exception. I am for nuclear power and for the midterm thirty to forty percent should be represented by nuclear power against the total power generated. As for direct disposal or reprocessing options in order to maintain nuclear power you have to have the backend focusing toward nuclear fuel cycle. But for the Rokkasho reprocessing whether I am for promoting or not for promoting I am not for promoting. So those are the perspectives and positions I take. There have been already explanations made by those who are for promoting the Rokkasho Plant. But what would be the largest risk factors for maintaining nuclear power? How to dispose of the wastes generated, in other words, backend issue or backend risks? Minimizing backend risks would be the key for maintaining nuclear power policy in that regard. But what is being tried is quite exceptional internationally, because they are about to make decisions just taking the one option of reprocessing which would be quite risky. Mr. Kawada said that reprocessing is not a minority, but actually reprocessing includes full reprocessing and partial reprocessing. I think Italy may be the least dependent on nuclear power, but it is dependent on other countries in Europe. In Europe they are helping each other in terms of dealing with the backend issues. In the Interim Report they have looked at four scenarios and as Mr. Uchiyama said the direct disposal as compared to reprocessing has been confirmed to be less expensive, but they have added the policy change, what they call, the policy change cost to actually turn the tide towards the reprocessing plant. The Rokkasho Plant closure cost, I think, this would be the cost that would be incurred whether or not, regardless of the options. It is very strange that this is added only for direct disposal. Also the fossil power stations will have to be built in order to cover the shortage. If the reprocessing is not done, direct disposal is the option and that is the common practice in Germany and the US. In Japan the related local governments where the nuclear facilities are located have they looked together with the national government by really weighing the cost of building new nuclear, fossil facilities and the direct disposal. I really do not understand why they have not done this as a pro nuclear position. For utilities and the private sector if

something happens to the Rokkasho Reprocessing Plant and if they have not counted the management risks properly, then consumers and stockholders will severely penalize the utilities. The policy change cost and the cost including direct disposal and the cost of combining those will have to be seriously compared, otherwise the shareholders will not be convinced. As the Interim Report says if you just take the option of reprocessing with the Rokkasho, I think, that would really increase the management risks for utilities. The nuclear power may not be maintained if this is the option that they have decided in trying to put into together the outline of nuclear power at this time. This is just a realistic view that I have. Thank you.

(Mr. Kato)

We have covered three major issues and we have heard your views on them. Rather than having free discussion in this particular session, we have only twenty minutes or so, but there are some time is given to me to summarize their discussion. But that is not really necessary. Maybe we can go to maybe four twenty-five. Let us use this available time to talk about some of the issues raised the some the sharper contrasting views. First there was a talk about risk, and then economics, various issues, viewpoints were given. But let us focus on those two points, risk and economics. Concerning risk there were very divergent views, but based on what has been discussed the three overseas speakers made their presentations in concise manners. I think I should give them some time to speak up now since they traveled so long distance to get here. Let us have the three speakers from overseas. Maybe you can raise your hands to decide the order to speak at this moment.

(Mr. von Hippel)

I will make two points. The first one as Kawada san mentioned the fact that US is having renewed the debate over reprocessing because of problems with the radioactive waste depository. We are having a renewed debate and I have written an article about that which, I hope somehow you have received copies on this; I brought about a hundred copies on this debate giving my perspective. It is also available on the website of the Journal Arms Control Today this month if it is not already. I do not think that in fact the result of this debate will be that US will reprocess. I do not think US utilities will support the reprocessing because they know how costly this now. Japan's utility did not know how costly it would be when they committed in the 1970s. I think they regret that commitment now over their tract. US utilities have seen as what is happening in Europe and Japan and I do not think they will make the same

mistake. I would also like to reiterate and expand something I said in my talk. There is no reason to operate the Rokkasho Plant at this time. Japan has excess separated plutonium and the reprocessing plant would simply be separating plutonium and to be stored. The problem with that is that plutonium is a directly weapon-useable material. Any country that is separates plutonium can have nuclear weapons within weeks. Also terrorists, if they are able to steal plutonium, might be able to make nuclear explosives with the power equivalently to about at least one thousand tons of chemical explosives. Such an explosion would destroy most buildings within the distances of a kilometer. Or more easily, terrorists could use plutonium oxide to make a radiological dispersal device. Inhalation of about ten grams of plutonium by the population will cause one thousand cancer deaths. The obvious question is if this material must be stored in not used possibly and probably for decades in any case why not keep it in the spent fuel where it is inaccessible to terrorists? Finally I want to stress that even though Japan is not interested in acquiring nuclear weapons other countries may be pointing to Japan's example. Two months ago I had a discussion with Iranian nuclear negotiator and one of them argued with me was if Japan can have a nuclear weapons option why can not Iran? That was what they said that Japan's policy of reprocessing has international as well as domestic implications. Thank you.

(Mr. Kato)

Thank you very much for that. Concerning that comment Mr. Kawada or Mr. Yamana, would you like to respond? Please, Mr. Kawada.

(Mr. Kawada)

In the end of that remark if Japan does reprocessing other rogue states would want also reprocessing, so we should not do it. That was a point, but I think that is not an essential issue because they are not interested in reprocessing they want nuclear weapons. The reason for that is because US and Russia, these kinds of nuclear weapon states have many bombs or nuclear weapons. They have demonstrated that it gives them political superiority in the international relations. North Korea has been breaking the IAEA rules and they are not going to give up just because Japan gives up reprocessing. I think we need to control them with international rules and if they break such rules the Security Council must effectively constrain them unless who are able to do that. It is no use for the best student, Japan to self regulate and refrain from reprocessing. It will not deter the rogue states to pursue their goals.

(Mr. Kato)

Please.

(Mr. Yamana)

Mr. Kikkawa and Mr. Hippel said if you go to direct disposal you have more stability. Concerning that view I think rather that we have more stability but pursuing reprocessing and I would like to explain why. As I said earlier, the reprocessing of spent fuel is not just to extract plutonium. It is a part of the comprehensive fuel management. You separate plutonium and uranium and you can take the fission products more quickly to disposal. This is a stable back-end strategy that we have been preparing for many, many years. So the two gentlemen talked about using plutonium certainly to make use of the plutonium you need a fast breeder reactor. Plutonium is the only way to manage plutonium to use and store plutonium on ground. It is a part of the fuel management program. In terms of stability most important is that we create a system that we can dispose of high level waste more quickly and so we have taken many years to site the facilities, set clear laws to prepare for this. As a result certainly it has led to higher cost of the reprocessing plant. But we worked twenty, thirty years to create that framework. If we switch over to direct disposal, that would have a very strong shock effect. That has not been explained and it is not just a monetary parameter that can be calculated the policy change cost, but also in terms of employment, and in terms of disposal of harmful waste we do not have any outlook or the economics of direct disposal. At this point of time we are free to pursue that we do not know what will happen. If there is more stability to change reprocessing policy we need to look at the shock or the impact of direct disposal. With reprocessing we have infrastructure, approach, a law that has been developed over many years and solidified. We are just about to start that process. In terms of instability I think Mr. Kikkawa was talking about the operation rate and that would be a technical factor and how stable the reprocessing plant would operate will be a technical matter to be discussed.

(Mr. Kato)

Mr. Yoshioka.

(Mr. Yoshioka)

There are a few slides that I would like to project. I will only spend three or four minutes. It seems that the discussion is focused on the things that are not risks, so I

would like to talk about a more general point. The evaluation on the four abstract scenarios is quite meaningless in my view. Mr. Kondo, please give me a break, you must be kidding. That is what I thought. What are you evaluating? What is the problem to solve? What is the appropriate methodology to solve? Of course this will decide the management of companies or other organizations, and they may go bankrupt based on poor decisions. The major problems are the following. 1. Rokkasho Plant should be started rapidly or not. 2. The reserve funds for reprocessing should be introduced or not. 3. Whether reprocessing is made mandatory to utilities or not. I have been stressing this point since the early stage of discussion at the New Policy Planning Committee of the JAEC. The general comparison between the reprocessing line and the direct disposal line is not an urgent issue. We have to choose the most rational option. I think Mr. Kikkawa agrees to this point.

Now, the Rokkasho plant is going to be started, and the reserve fund is going to be accumulated, based on the interim report. But there is no benefit out of that because there is already twenty-five years worth of plutonium that are stockpiled. The expense will be quite large, because there will be a negative factor on non-proliferation scheme, and additional risk for safety and environment, and also financial risk of electric utilities, and the risk of more burdens on the tax payers. Apparently, the moratorium option is better than go ahead option. Why is it that Mr. Kondo has decided otherwise? If the scenario comparison analysis like that of the Interim Report will be useful, it should be incorporated in the longer term decision.

What is evaluated at the New Policy Planning Committee that made Interim Report? Which policy is the best for the public benefit, was not discussed. What is the best choice for the maximization of the benefit of the nuclear community was the main issue. Maintaining the current status quo is the basic starting point. They just calculated the cost of changing that policy. They are just focusing on the short term expense of the policy change, and also evaluate the benefit of that, from the perspective of conservative thinking.

So that frank discussion is something that we need. If the policy is changed, of course, there are several major costs from the perspective of conservative thinking. For example, current Bush administration is quite tolerating Japan's vested interest. If the U.S. Democratic Party had won the election the situation might not be what it is now. It is natural for nuclear promoter to enlarge vested interests under the Bush regime. Domestically, the change of reprocessing policy could affect the nuclear power as a whole. There are various stakeholders, and if the reprocessing is abandoned, then the re-coordination of the interest of the stakeholders will be quite difficult. That is

something that should be given the first priority in this whole discussion, it seems. If that is the way the public policy is decided, the realistic cost of the policy change is of utmost important.

Is it really considered to be all right? That is what I wanted to say finally. Although the vested interests of the stakeholders in the nuclear community are given the first priority which was the case up until now, there should be some other solutions if we give the priority to public good. The Rokkasho Reprocessing Plant should be frozen for the moment, and then we should spend more time in deciding the options. This is the most reasonable option from the perspective of public interest. I have not insisted at the New Policy Planning Council that we should decide either of reprocessing or direct disposal. Lastly, the role of the government is quite important. The government has made various promises with stakeholders, but many of them have not carried out yet. As a result, stakeholders are trapped in those promises. It is only the government that can change those promises. If they say they will change the promises based on reasonable reasons then the stakeholders will respond. First of all the government has to apologize and they have to say they will change their promises first.

(Mr. Kato)

Mr. Yoshioka has aside from the theoretical values there are realistic issues. Rather than talking about reprocessing or direct disposal we have to look at what to do with the Rokkasho first. The government financial risk, safety and non-proliferation- from those three perspectives there is no reasonable rationale to start the Rokkasho. As for policy change cost this is my area of specialty by the way the policy change cost will be different depending on who is involved. Is it the general public or is it the stakeholders? It could be totally different conclusion. So the policy change cost is quite ambiguous. The policy change cost to who should be clearly defined, otherwise discussions will not be converged. Based on the assumption, Mr. Yoshioka just said that we should perhaps look at more realistic issues. I was just told that we could extend this discussion slightly, maybe past for thirty.

(Mr. Schneider)

I would like to, since you have mentioned the term realistic, I would like to make a couple of comments because I have the feeling that when I hear specially Yamana-san and Kawada-san that these are basically the same arguments that have existed for the last thirty years. The problem is that they do not seem to take into account that reality

has actually changed over the last thirty years. I want to give a few examples. The theory is that separated plutonium can be recycled. I mean Japan has been separating plutonium for nearly thirty years. So far zero plutonium has been re-introduced into light water reactors and very little into fast breeders. The theory is that fast breeders allow savings of uranium. Reality is that the Monju reactor has been down for almost ten years. In December it is going to be ten years and it is actually consuming electricity and not very little because it needs to heat sodium in order to keep the sodium liquid. So it is actually an electricity consuming facility and not an electricity generating facility. The theory is it has been said that liquid waste is immediately conditioned, immediately put into solid form. Reality is that there is a huge backlog at Sellafield in the UK and La Hague in France, over a thousand cubic meters at each site. Now the equivalence is, at each site, several dozen times the cesium content that was released at the Chernobyl accident. We are talking about very significant risk inventories. The theory is, and I quote "physical protection can be perfectly done." It was said concerning MOX shipment. Now reality is that Greenpeace with a few activists was able to block and totally immobilize a plutonium truck for several hours. That is reality. Theory is that there is little cost difference between reprocessing and non-reprocessing. Reality is THORP, reprocessing plant in UK, is shut down because of a very major leak costing hundreds, hundreds of millions of pounds. Now is that all integrated in the cost calculation? The theory is to calculate a kilowatt hour cost over forty years of electricity generation. The reality is that 17 TEPCO reactors have been down for up to over two years. Is that integrated in the cost calculation? Et cetera, et cetera. There are so many real facts that actually have changed considerably the situation from the theory of physics which, of course, theoretically if you reuse plutonium you will make better use of uranium. That is physics. That is law of physics. It is very true, but it is not reality. The problem is that to turn the physics law into reality it needs a huge amount of facilities, money and time. Those time frames are just not respected. Thank you.

(Mr. Kato)

Thank you very much. Mr. Uchiyama, please.

(Mr. Uchiyama)

Concerning risk, realistically speaking, use of plutonium in the nuclear power plants creates risk I think that was the point made. I think there are various types of energy related risks and how to make a judgment about the risks from a long term perspective

is quite important. How do we choose what energy do we choose is related to how we reduce the risks. If you use oil or fossil fuel basically stable supply of energy in our country and in Asia would not be realized. There would be very high risks. Now if we use renewable energy that would result in a very high financial risk. If we use nuclear energy certainly we need thorough and perfect management in terms of safety. That is the risk. Using uranium means that at least at the uranium mines there is contamination, pollution. So with a one through strategy you are increasing that pollution. People might say just pay for it. It is not Japan's risk if there is a risk associated with coal we are importing. So why do not we just pay for that with money? But I do not think that philosophy is a just one. Energy that we use involves risks. We have to be responsible for securing that energy source. What enables to view is that kind of risk is nuclear power generation, recycling leading to FBR. Political and economic risks are quite large with other approaches. Japan has a world class technology. Under its determination to create this we must try to overcome these various risks. I think that is important.

(Mr. Kato)

Please, Mr. Küppers.

(Mr. Küppers)

Also I want to make a comment to reality and perspectives. Perhaps you all remember we have seen some figures today where MOX and uranium fuels were compared with contents of special radionuclides and such things. Of course you can compare uranium and MOX fuel and you can say plutonium is taken away and then this plutonium is not in the final disposal. We have seen such figures. But I think we have to look on the final result of every strategy. This means the plutonium is reused then there is another waste. This waste is more dangerous and then there is more inventory of problematic radionuclides in the final disposal. It is also not very wise to compare only radio toxicity of the materials because then you would say you take this material and take it in your body. But the reality is another one. For example, if the impact of the nuclear power plant is calculated is also not said there, there are noble gases and there is iodine and such things and we take the radio toxicity of these radionuclides and add it. The transformation of the environment is moderate and this change is...in reality changes very much in such a comparison. What must in reality be done is to calculate those in the future when the final disposal is closed, for example, one million years and to look for those with recycling plutonium, without recycling

plutonium, with the fast breeder reactors, without the fast breeder reactors. The third point, we also have seen a figure where it was shown for the same electricity output in the light water reactor one hundred seventeen tons of uranium and heat it and in a fast breeder reactor one ton of uranium. This is the status in the far future and this can not be done at the moment. This means that they must be a lot of fast breeders and perhaps in some decades even far in the future such things may be the case, but at the moment this comparison is not very helpful. So a real helpful comparison must compare also the time from now to this status. So how much uranium will be consumed until this status is reached? I think then the comparison gives a very different result. Thank you.

(Mr. Kato)

Thank you very much. Concerning that point, would someone like to respond? Mr. Yamana. Just one thing. FBR, you talked about the feasibility of it. What is it really? What is the feasibility of actual having your fast breeder reactor?

(Mr. Yamana)

Those people are not involved in the FBR like Professor Yoshioka. They say it is not feasible, but the engineers were involved in the actual development economically, well it has not reached the level of economic feasibility. But physically speaking it is feasible. When will it become cheap enough? It will be just a matter of an introduction of time. It will just be a matter of when the economic mechanism will encourage the introduction. We are comparing the road map to increase the economics and by the precise development certainly I think we have reached a quite high level. May I take a different point? Considering all just said the difference between overseas panelists and ourselves, I think, one major difference is the time axis. We are always thinking and focusing on the long term risk. We are not talking about the short term impact of plutonium, but for all the long term several decades in the future to maintain certain technology or to talk about stability that arises by having a certain technology. That is what we are focusing on. Mr. Schneider earlier said the situation has changed and we think the situation is continuing to change. That is that you have abundant uranium. By 1980s people had abandoned theory that we needed to produce more plutonium. But from a long term view point to have a sustainable future we need to have the nuclear fuel cycle and to have a plutonium in our hands. That is necessary from a long term perspective. As a transitional period we are focusing on the pluthermal. The situation is changing that is that the world energy

situation, especially Asian energy demand is increasing. There is a shortage of oil. We think this kind of changes will continue and the outcome of that will be clear in twenty or thirty years' time.

(Mr. Kato)

Professor Kikkawa. Could you please speak for one minute?

(Mr. Kikkawa)

From the long term perspective, for that very reason, why do we have to rush for decision to start the Rokkasho? You are courageously enough to be here to say that reprocessing should be promoted. But in order to promote that reprocessing the Rokkasho decision has to be delayed. Technologies can not be accumulated overnight. Especially for major large scale of technologies it takes at least forty years to secure reliability. So we have to make tedious efforts to build up the reliability. That is why.

(Mr. Kato)

OK. I will give one minute for each.

(Mr. Schneider)

Yamana-san, do you put into question the figure I have been giving that in the best case it would be less than one percent over the next, let us say, twenty-five, thirty years of the final energy consumed in Japan which would be covered by plutonium? Would you put that into question? The other point is that the first nuclear reactor that actually produced electricity was a fast breeder reactor. It was the EBR-1 [Experimental Breeder Reactor] in the United States and it is fifty years ago. You have been working already for decades on these machines. The interesting thing is that the system failed. I mean there is a clear and perfect illustration that it did not work out. The fact is that the only industrial size fast breeder in the world, which was the Superphenix in France, has been shut down for good reasons. I could tell you the history of that plant but it is not the moment now. However, it shows that the country that was the most advanced in that area has actually decided to cut the head of the program.

(Mr. Kato)

To respond, please spend only thirty seconds.

(Mr. Yamana)

One percent proportion for plutonium. This is what I think. In Japan the energy self-sufficiency rate is four percent excluding nuclear power in terms of the primary energy. For power generation nuclear power represents about thirty percent. Of that thirty percent of the total power generated...

(Mr. Schneider)

Final energy?

(Mr. Yamana)

Nuclear power. Nuclear power accounts for thirty percent. The hydropower is about little less than ten percent. In nuclear power by using pluthermal, about fifteen percent of uranium can be saved. That is our calculation. If the fifteen percent of uranium can be saved thirty percent of the total meaning thirty times of 0.15 meaning six percent of the total power generated. Plutonium fuel is considered to be domestic fuel which increases self-sufficiency for energy. Five or six percent of the total power generated is about the proportion for hydropower may be a little less than hydropower which is seven or eight percent. That means that we can have self-sufficient nuclear power which represents five or six percent. Imported uranium fuel can be saved for fifteen percent. Four thousand four hundred SWU tons per year should be used for enrichment. Of that forty-four hundred tons, fifteen percent means five hundred tons. The enrichment which is about to be built...

You can replace the thirty percent of that with the self-sufficient domestic fuel and ultimately the fast breeder reactor can use the domestic fuel. Thirty percent of the total nuclear power could be domestic fuel. This comes from self-sufficiency of the energy in Japan.

(Mr. Kato)

If we start talking about this then we could go on forever. There are three members that have raised their hands. Thirty seconds each, please. One by one.

(Mr. Iida)

The point is why now, why should we start Rokkasho now. As Mr. Kikkawa said we have been deviating from this topic, but I would like to make an additional comment. Those who are for reprocessing are technical theory from the engineer's perspective

which is more of illusion. If you look back the past then light water reactor at the current time the technology that we have in Japan only riding on the technology that US has. It is not fully domestic technology. As Mr. Yamana tried to answer whether this would be feasible perhaps one generation would be just as much as we can go. But the distributed power for every one to five years one generation of an advancement has been made. For photovoltaic and wind power eighty-five percent of cost reduction has been made by doubling production. We do not think the fast breeder reactor technology will be spread just like the distributed power.

(Mr. Kato)

What do you think about carrying on with the research on the fast breeder reactor?

(Mr. Iida)

I think that can be done, but that is a separate topic from whether we should start the Rokkasho.

(Mr. Kato)

Mr. von Hippel.

(Mr. von Hippel)

I just would like to say that Japan's plutonium would be available to Japan. If it is needed it certainly comes economically to use it. It is stored fuel and the stored fuel is not going to go anywhere. So I do not understand what the rushes to do it at the time when it is said uneconomic when Japan already has a surplus of separated plutonium.

(Mr. Kato)

Mr. Kawada.

(Mr. Kawada)

The environment surrounding nuclear power may have been changed. From that perspective for the past ten years what has changed is the preparation for disposal of high level waste has advanced in the world. Of course, we have not reached the stage where it is already realized, but as a result of this advancement we have been able to identify what the problems are, issues are. For twenty-seven years the US has opted for direct disposal, but now they are in doubt. For the past twenty years US has hated

reprocessing. I do not think they will quickly switch to reprocessing, but if they can create and build four or five final depositories that is something that they have a doubt on. For the reason why I promote reprocessing now is that freezing this program will quickly increasing the number of storage facilities and the Mutsu facility in Rokkasho will be abundant and the interim storage facilities will have to be built. Right near the nuclear power stations whether this will be accepted or Japan can get over that. That is something that we need to discuss and that is a major issue. The meaning of doing reprocessing is not for saving a little amount of uranium, but in the era in the full scale uranium efficient use is done probably 2040 or 2050. Between now and then through various international frameworks there will be a social infrastructure that will be prepared and we will accumulate also technologies to do that because nuclear power is based on technology. We need to nurture technologies and develop technologies and also build the infrastructure. That is the most meaningful step.

(Mr. Kato)

Because of this heated discussion there is no time left for me as a coordinator to summarize the discussion.

(Mr. Fujimura)

I would like to make some comments before you wrap up. Mr. Yamana said that system for the disposal of high-level vitrified waste has been established, and then the policy change to direct disposal will give a large impact. But, so far, there is no municipality to apply for the voluntary siting system for vitrified high-level waste disposal. I do not think that the policy change from reprocessing to direct disposal does not make this situation worse. You talked about how low the exposure dose is for vitrified high-level waste disposal, but as I have shown today the low-level waste from a reprocessing plant will have a higher exposure dose. And now it is discussed the plan to bury them in the same site for geological disposal of vitrified wastes. This means the waste of higher exposure is add after only showing lower value of exposure dose of vitrified waste. That is the way to loose the credibility of nuclear power policy. I think such incredibility is the reason why local municipality with nuclear facilities held this meeting. Furthermore, it is said that the interim storage facilities are not going to be promoted so easily because you can not have such a friendly discussion with the local community. In that sense, today's meeting is a good opportunity to triggering off a discussion with the local community.

(Mr. Kato)

Listening to your discussion and those who are not for reprocessing they seem to be seen that we do not have to rush at this point. For those who are for reprocessing you seem to be looking at the long term perspective. If we have more thorough discussion then there may be a way that we can find a consensus, but realistically how the corporations and the stakeholders are involved. That is a realistic issue. The US may be starting to think about changing policies. In either way the policy change cost will be incurred. If the US is trying to change their policy, may be trying to change their policy then the policy change cost is something that should be born by somebody, but who is mainly paying for the policy change cost? That would lead to a conflict of interest, but there is a room for the discussion on that point. During the break time the parties from both positions are said that this has been a very productive discussion where people from both sides were able to become very frank with their opinions and I am sure this has been the biggest effect and outcome that we are able to will enjoy out of this discussion. I am sure you have the same view.

- A request from the floor for a comment -

(Mr. Kato)

Now we ask that you would fill in the questionnaire because of this scheduling issue. We have to leave the hall now. I am very sorry if you could fill in your comments in the questionnaire.

- A request from the floor for a comment -

(MC)

We have very much overshot our schedule. If we had a time we would have wanted to answer those questions.

Mr. Kato on the panelist, thank you very much. Lastly Governor of Fukushima Prefecture would like to say a few words of appreciation.

(Governor Sato)

Thank you very much. It was a long session, but listening to the active debate, it seems like a short period of time. There were many views presented from the panelists. Mr. Kato, I think, had a very difficult challenge as the coordinator. About

in thirty seconds or one minute people voiced very useful and formative views. From about ten years ago we have been studying the nuclear energy policy because there were many questions that came to our mind that needed to be resolved. We have been holding various meetings on science and technology in the society. The relations between two and also the process of policy-making, we have worked on those issues. Now at the Diet they are talking about postal privatization and now the Diet has been disbanded just under the issue. We should have an election just for the nuclear fuel recycle. That is a sort of dream for me. As the panelists put forward various views and it will take me about one week to sort out all those different viewpoints, but we would like to make the best use of the information provided today. It is up to you to make your individual decisions, but we want to make sure that we chart our future plans to the right direction. I talked about the policy decision making process, but the current system where we do not even need a resolution of the Diet. I think that needs also to be questioned and we would like to discuss with you that issues as well as many other issues, put into the issues. With the panelists, the coordinator, and all the people in the audience, we really wanted to have more active debate, but unfortunately because of the time we could not do that. Thank you very much for you attendance.

(MC)

Thank you very much. With that we would like to close this international symposium concerning the nuclear fuel cycle. One request to you on an announcement. We have distributed the ICRC report. The telephone number on the cover was misprinted, so I will orally announce the phone number. On the back of the document there is a phone number; 03-5318-3331. That is the correct phone number. If that is not clear please contact the secretariat. Thank you very much for your attendance. Some more announcements. From five-twenty the ICRC members will hold a press conference in the lobby. In the lobby from five-twenty we will have a press conference. Thank you.